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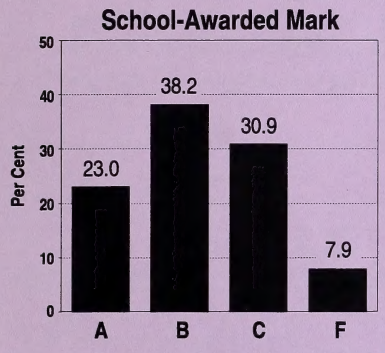
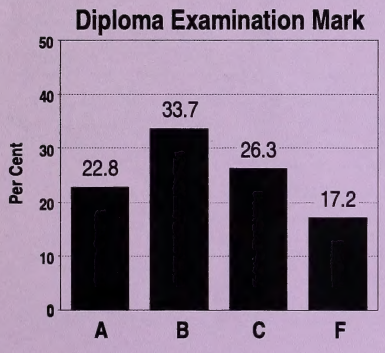
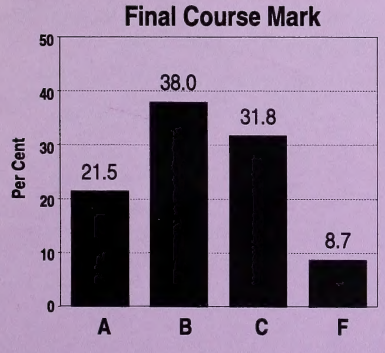
Chemistry 30

Diploma Examination Results
Examiners' Report for January 1993

APR 26 1993







The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1993 administration of the Chemistry 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Chemistry 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of three questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 8 073 students who wrote the January examination.

- 91.3% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 21.5% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Chemistry 30 was acceptable, particularly in knowledge of core concepts. However, students continued to have difficulty with laboratory-related skills and processes, and in organizing and communicating their chemistry knowledge.

Provincial Averages

- The average school-awarded mark was 68.1%.
- The average diploma examination mark was 65.9%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 67.5%.

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Subtest

When analyzing detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 32.8 out of 48

- Chemical Energetics: 9.4 out of 14
- Acids and Bases: 12.2 out of 17
- Oxidation-Reduction: 11.2 out of 17

Cognitive Levels

- Knowledge: 15.1 out of 20
- Comprehension and Application: 14.9 out of 21
- Higher Mental Activities: 2.8 out of 7

Written response: 12.7 out of 21

Process Skills: 23.1 out of 38

Examination Blueprint

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the cognitive level demanded by the question. The examination blueprint illustrates the distribution of questions in January 1993 according to these classifications. In the machine-scored section, numbers in parentheses ( ) indicate numerical-response questions and those without brackets or parentheses are multiple-choice questions.

	Machine Scored			Written Response	
Subject Matter	**Knowledge**	**Comprehension and Application**	**Higher Mental Activities**	**C/A, HMA, and Communication**	**Exam Emphasis**
Chemical Energetics	1, 2, 3, 5, 6, 7, 8 (1)	10, 11, 12	4, 9 (2)	2	32%
Acids and Bases	13, 14, 15, 16, 20, 25, 28	17, 18, 19, 21, 22, 23, 27 (3) (4)	24, 26	1	34%
Oxidation-Reduction	29, 30, 31, 38, 41	32, 33, 34, 35, 36, 37, 39, 40 (5)	42 (6) (7)	3	34%
Exam Emphasis	29%	30%	11%	30%	100%

Note: In the table above, those questions which involve the use of science process skills from the multiple-choice section of the examination are 1, 3, 9, 11, 12, 13, 19, 21, 24, 26, 34, 38, 37, 40 and 42; those from the numerical-response section are 3, 5 and 7; those from the written-response section are 1, 2, and 3.

Science process skills received an exam emphasis of 56%.

Cognitive Levels received a total examination emphasis of

- Knowledge 29%
- Comprehension and Application 51%
- Higher Mental Activities 19%

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% or higher and students capable of achieving the standard of excellence will obtain a mark of 80% or higher. Future examinations will continue to require students to demonstrate clarity in their thinking and an understanding of concepts by applying their knowledge to new and novel situations. Students who achieved these expectations were successful on this examination. The next series of diploma examinations will continue to require students to communicate their answers in a clear, concise, and organized fashion.

Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty*	Question	Key	Difficulty*
1	B	90.0	15	A	74.1	29	C	83.2
2	C	52.8	16	B	78.2	30	B	73.2
3	C	57.2	17	B	90.9	31	D	85.2
4	D	63.5	18	D	54.1	32	A	63.6
5	B	74.0	19	A	41.1	33	A	89.1
6	C	75.0	20	C	93.1	34	C	67.7
7	A	52.2	21	B	85.7	35	D	85.9
8	A	90.2	22	B	79.2	36	A	69.9
9	B	32.5	23	A	75.4	37	A	30.9
10	B	83.0	24	D	deleted	38	B	68.5
11	B	82.2	25	D	64.5	39	C	75.3
12	C	51.9	26	C	35.1	40	D	86.3
13	A	84.2	27	D	75.7	41	C	68.5
14	D	80.1	28	B	72.0	42	C	38.4

*Difficulty—percentage of students answering the question correctly

Detailed comments on three questions follow.

24. 47.0 mL of a monoprotic acid solution neutralizes 56.0 mL of 0.010 mol/L $Ba(OH)_{2(aq)}$. This monoprotic acid solution also causes methyl orange to turn red and causes orange IV to turn yellow. What is the per cent dissociation of this acid?

A. 0.89%
B. 2.1%
C. 3.0%
• **D.** 4.2%

Question 24: was deleted from the examination because it contained two chemically correct answers. If students elected to determine the maximum range of possibilities, both alternative C and D, which was the keyed response, would fall into the range.

The following two questions were selected for discussion because they exemplify what is required to meet the acceptable standard and the standard of excellence.

14. A solution contains more hydrogen ions than hydroxide ions. Such a solution

A. is neutral
B. has a high pH
C. is a nonelectrolyte
• **D.** turns phenol red to yellow

Question 14: Most students (95.8%) were able to identify that the solution was not neutral, and 80.1% of all the students correctly identified that the solution was acidic and thus that it would form a yellow solution in the presence of phenol red. Of the students who answered incorrectly, 7.4% associated acidity with high pH and did not recognize the relationship between pH and acidity. The results for this question suggest that students attaining the acceptable standard understand fundamental concepts such as acidity and pH and are able to relate these concepts.

Use the following information to answer question 37.

A student made these observations after mixing several test solutions with samples of TTE (1, 1, 2-trichloro- 1, 2, 2-trifluoroethane).

Solution	Color of TTE layer
$Cl^-_{(aq)}$	colorless
$Br^-_{(aq)}$	colorless
$I^-_{(aq)}$	colorless

Solution	Color of TTE layer
$Cl_{2\,(aq)}$	colorless
$Br_{2\,(aq)}$	orange
$I_{2\,(aq)}$	pink

She then mixed various combinations of solutions and obtained these results:

I. $Cl_{2\,(aq)} + Br^-_{(aq)}$: TTE layer orange
II. $Cl^-_{(aq)} + Br_{2\,(aq)}$: TTE layer orange
III. $I^-_{(aq)} + Br_{2\,(aq)}$: TTE layer pink

37. The reaction(s) that shows that bromine was produced is(are)

- **A.** I only
- **B.** III only
- **C.** I and II
- **D.** I, II, and III

Question 37: Only 6.0% of all the students had no idea of how to interpret the data and assumed that all combinations of reagents resulted in spontaneous reactions. Most of the students (83.8%) correctly recognized that an orange solution indicated the presence of dissolved bromine. However, many (52.8%) did not recognize that the presence of dissolved bromine does not indicate that a reaction has occurred. Only 30.9% of all the students were able to interpret the information and then determine that only one reaction produced bromine. This result suggests that students have limited ability interpreting data and drawing accurate conclusions, and that those students who do not attain the standard of excellence cannot transfer empirical information into a conceptual framework.

Numerical Response

Virtually all students correctly followed the instructions for filling in the answer sheet. Students who did not round their answers as instructed lost marks.

Question	Answer	Difficulty*
1	33.2	92.4
2	85.7	40.4
3	1.70	56.2
4	1, 4, 3, 2	73.1
5	6, 4, 4, 6,	67.4
6	6.00	4.5
7	1.25	65.1

*Difficulty—percentage of students answering the question correctly

Detailed comments on two questions follow.

4. The following are hypothetical reactions:

1. $H_4X_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons H_3X^-_{(aq)} + HCO_3^-{}_{(aq)}$
2. $HX^{3-}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons X^{4-}_{(aq)} + HCO_3^-{}_{(aq)}$
3. $H_2X^{2-}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons HX^{3-}_{(aq)} + HCO_3^-{}_{(aq)}$
4. $H_3X^-_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons H_2X^{2-}_{(aq)} + HCO_3^-{}_{(aq)}$

The order of these reactions, beginning with the one that forms the most product to the one that forms the least product, is _____. (Record all four digits.)

The average for **question 4** was 73.1%. This question discriminated well between weak and average students. The only recognizable mistake students (11.3%) made was reversing the correct order of the reactions, which implies that these students do not understand the relationship between the extent of reaction and the amount of product formed. This suggests that students achieving the acceptable standard do so because they are capable of tasks such as recognizing that the strength of a polyprotic acid diminishes as the number of hydrogens is removed.

6. When 1.20 mol of $H_2PO_{4\ (aq)}^-$ react according to the equation $12H_2PO_{4\ (aq)}^- + 12H^+_{(aq)} + 10Br^-_{(aq)} \rightarrow 3P_{4(s)} + 18H_2O_{(l)} + 10BrO_{3\ (aq)}^-$, the number of moles of electrons transferred is _____ mol. (Record your answer to three digits.)

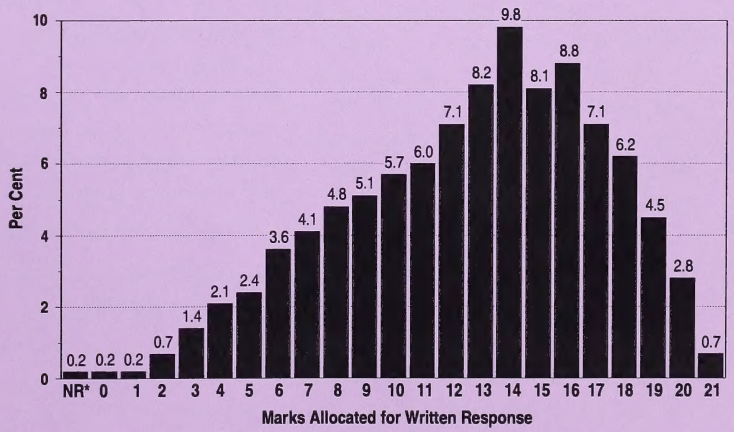
The average for **question 6** was 4.5%. This question discriminated very well between strong and fairly strong students. The question did not involve half-reactions normally found in the Chemistry Data Booklet, and as a result, 12.1% of all the students did not attempt this problem. The most common mistake students (16.2%) made was multiplying a coefficient by the number of moles of the dihydrogenphosphate ion. Another mistake students (10.4%) made was assuming a 1:1 ratio. The next most frequent mistake (7.6%) was assuming that there is always 1.00 mol of e^- transferred in a reaction. Lastly, 1.0% of the students decided that the reaction was not a redox reaction and hence that no electrons would be transferred.

The results for this question suggest that students exceeding the standard of excellence can successfully extract the fundamental processes from existing situations, reapply these processes in new situations, and where necessary, perform valid calculations.

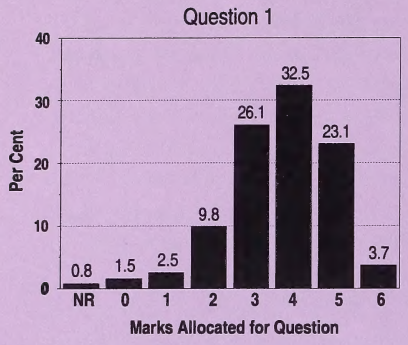
Written Response

The level of achievement on the written-response section was better than expected: over two-thirds of the students (69.4%) achieved a mark of 11 or higher out of 21. The average mark on the written-response section was 12.66 or 60.3% of the available marks.

Despite this better-than-expected performance, there was a major disappointment: all students demonstrated great difficulty with common metric prefixes. Regardless of their ability, students appeared unaware of or could not recognize some metric prefixes. For example, they had difficulty in determining that one milliampere (1 mA) is 1×10^{-3} A, which is perplexing because most students clearly recognized that one millilitre (1 mL) is 1×10^{-3} L.



*NR—No Response

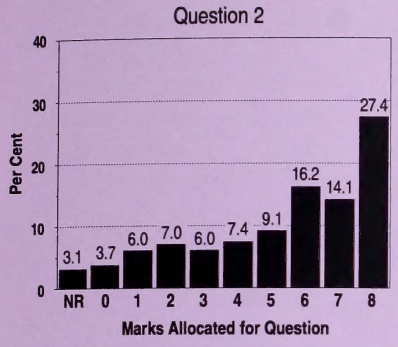


Question 1 was answered as well as expected. This was partly due to the dual purpose of the question: first, to measure students' ability to graph experimental data and, secondly, to test students' ability to extract meaningful information from the completed graph. A student who completed both could attain the standard of excellence. Students who did not meet the acceptable standard were unable to correctly address the latter part of the question. These students described the shape of the graph rather than explained what happened in the experiment. Most of them were able to construct a graph; however, the graphs exhibited incorrect scales, incorrect plotting of data, insufficient or incorrect labeling of axes, and the graphs looked as though students had "connected the dots" rather than drawn a smooth curve. In general, these students failed to effectively use the grid provided. Many did not indicate a point on the graph showing where the pH of the solution is 7. These students also had difficulty expressing themselves. As a result, markers had to interpret these students' responses, which in many cases contained errors in the conventions of the communication used.

Students who attained the acceptable standard but not the standard of excellence generally had good graphing skills. These students indicated the point at which the pH is 7. They could explain that rise in solution temperature is due to an exothermic neutralization reaction. However, these students had difficulty in explaining why the temperature of the solution peaked and then declined. They were, however, able to communicate their ideas well enough to the markers so that little, if any, interpretation was required.

Students who attained the standard of excellence constructed appropriate graphs, accurately located the point on the graph at which the pH is 7, and selected an appropriate indicator; most could determine the concentration of the base. These students were able to describe the base as being weak, and most were able to justify their answer. The only weakness that prevented these students from earning full marks for this question was their explanation of why the temperature of the solution dropped. These students presented their answers in an organized fashion and expressed themselves clearly to the markers so that no interpretation was required.

On this 6-mark question, the average mark was 3.68 or 61.3% of the available mark.

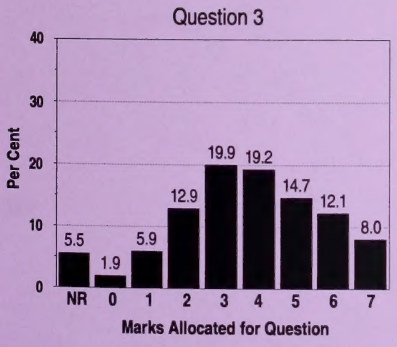


Question 2 was answered as well as expected. Students who did not attain the acceptable level knew the order of magnitudes. However, these students were unable to use a correct relationship and extract accurate values, which then could be used to identify the experiments. Most of these students' responses displayed very poor mathematical skills and were poorly organized and communicated.

Students who attained the acceptable level on the examination correctly determined the order of magnitudes but were able to recognize only part of the relationship, $mc\Delta t$, which they were able to calculate accurately. In many cases, these students' interpretations contradicted their calculations and, as a result, these students were unable to support their identification. The most common weakness in their responses was the failure to provide a justification for the conclusions they reached. However, the majority of the responses were well organized and easy to follow.

Students who attained the standard of excellence clearly communicated their answers. They had no difficulty in determining the relationship required to make an accurate comparison, nor did they have any difficulty in explaining the relationship and the outcomes or in calculating accurate values on which to make their correct identifications.

On this 8-mark question, the average mark was 5.28 or 66.0% of the available mark.



Question 3 was answered better than expected. Students who did not attain the acceptable level on the examination scored 0 to 2 marks, as expected. Most of these students could not distinguish between metals and nonmetals or elements and ions. As a result, they had difficulty in selecting an appropriate metal capable of protecting iron. These students also had difficulty in distinguishing between oxidizing and reducing agents and tended to react their selected metal with the iron rather than with materials from the environment. These students were capable of calculating a mass of a substance; however, they failed to recognize the ratio between electrons transferred and the substance. They made additional computational errors because they did not know metric prefixes such as milli (m).

Students who attained the acceptable level on the examination were expected to score between 3 and 5 marks. These students could select an appropriate metal but could not explain how this metal could be used to protect the iron. Many of these students justified their selection by showing that the metal they chose would

not react with the iron rather than showing how the metal would protect the iron from the environment. Most of these students recognized the correct method to determine the mass of their metal but had difficulty in determining the correct mass for their metal. The most common error that prevented this group from arriving at the correct answer was that they were unaware of the metric prefix milli (m); consequently, they had difficulty in arriving at the correct mole ration and thus produced very unrealistic and humorous answers; for example, 51 tonnes. In general, the responses by these students were well written and fairly well organized.

Students who attained the standard of excellence were expected to score 6 or 7 marks and they did. They selected a suitable and practical metal, explained how the metal would protect the iron, and performed the necessary calculations. The only error that prevented these students from attaining full marks was their inability to convert milliamperes to amperes. Their responses were well organized and their ideas were communicated clearly with essentially no communication errors.

On this 7-mark question, the average mark was 3.70 or 52.9% of the available mark.

For further information, contact Don Loerke or Phill Campbell at the Student Evaluation Branch, 427-0010.